Raytheon

Advanced Thermal Emission Imaging Systems Definition and Development

SF298

Quarterly Report
July thru September 2002

PREPARED FOR
NATIONAL AERONAUTICS & SPACE ADMINISTRATION HEADQUARTERS
Washington, DC 20546

CONTRACT NO. NASW-00037
DM NO. LB2L-0007
PREPARED OCTOBER 2002

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED *(From - To)*
09-30-2002	Quarterly Report	7/1/02 to 9/30/02

4. TITLE AND SUBTITLE
Advanced Thermal Emission Imaging Systems Definition and Development

5a. CONTRACT NUMBER
C-NASW-00037

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Dr. Karl Blasius, Raytheon Company

5d. PROJECT NUMBER

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Raytheon Company, Santa Barbara Remote Sensing
75 Coromar Drive
Goleta, CA 93117

8. PERFORMING ORGANIZATION REPORT NUMBER
LB2L-0006

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
NASA HQ, GSFC
Greenbelt Road
Greenbelt, MD 20771

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION / AVAILABILITY STATEMENT
NHB2200.2

13. SUPPLEMENTARY NOTES

14. ABSTRACT
Abstract is provided on page 1 of the attached Quarterly Report.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF: None			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Greg Lewis
None	None	None	None	4	19b. TELEPHONE NUMBER *(include area code)* (805) 562-7782

CONTENTS

INTRODUCTION

Santa Barbara Remote Sensing (SBRS), Raytheon Company, is pleased to submit this quarterly progress report of the work performed in the third quarter of Year 2 of the Advanced THEMIS Project, July through September, 2002. We review here progress in the proposed tasks.

1.0 Project Schedule

During July through September of 2002 progress was made in two major tasks, Spectral Response Characterization and Flight Instrument Definition. Because of staffing problems and technical problems earlier in the program we have refocused the remaining time and budget on the key technical tasks. Current technical problems with a central piece of test equipment has lead us to request a 1 quarter extension to the period of performance. This request is being made through a separate letter independent of this report.

The Project activities and progress are summarized in Table 1-1. In Table 1-2 we show the project activities refocused on the key technical tasks and rebudgeted through end-of-contract. Due to a need for extra resources to overcome technical problems in Task 2A Spectral Response Characterization and Design Modifications and Noise Characterization, four categories of work are recommended for resources cuts. These are 2B. Detector Radiation Testing, 4. Radiometric Calibration Approach, 5. Spectral Imaging Demonstration, and 7. Educational/Public Outreach Activity.

2.0 Task Progress

The Project is now staffed for tasks Detector Characterization and Design Modifications and Instrument Performance Model and Flight Instrument Definition. The Principal Investigator is devoting a significant fraction of his time to the project and serving as technical lead.

2.1 Detector Characterization and Design Modifications

We are focusing on setting up a laboratory environment for spectral response characterization. We previously brought into operation an FTIR spectral source, a Nicholet Magna 860 FT-IR Spectrometer. This instrument passed initial checkout last year, however, it failed this past quarter. A service call turned up a need for realignment and an upgrade in software and computer interface in order to run in the mode required for our measurements. We have ordered the repairs and expect total downtime of approximately 1 month.

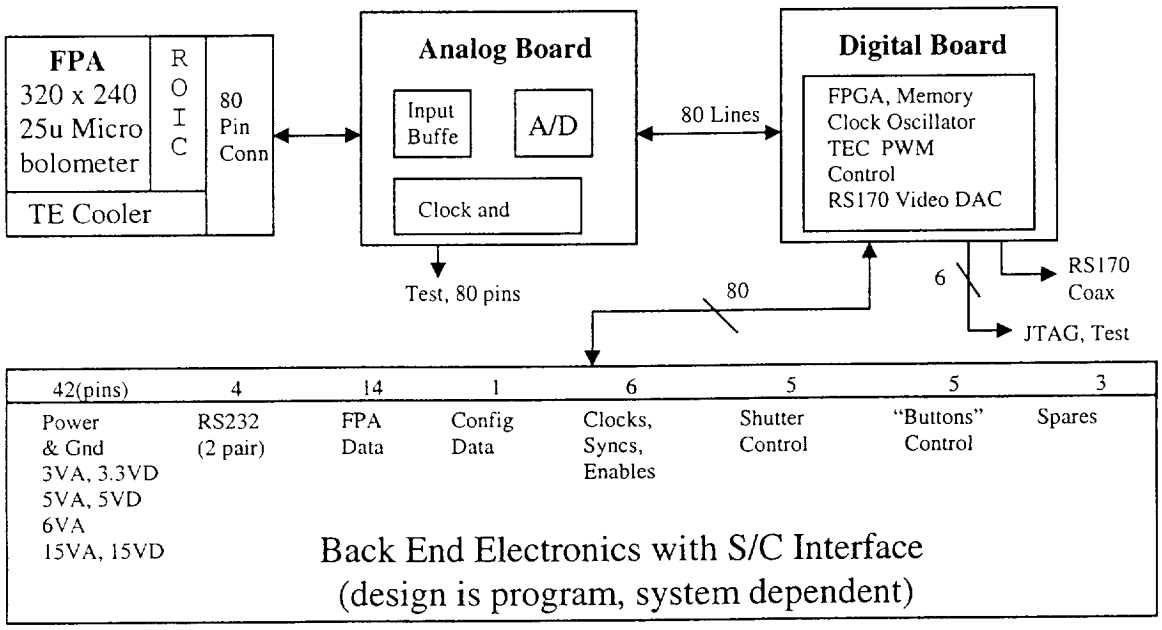
We have taken delivery of one packaged detector array (25μm pitch) from Raytheon Vision Systems, formerly Raytheon Infrared Operations. The second array (50μm pitch) failed during final assembly steps. A replacement is being assembled.

Our test electronics unit has been modified with upgrades to perform more functions as allowed by the post-THEMIS detector arrays we are testing. Improved gain and offset correction is expected.

2.3 Flight Instrument Definition

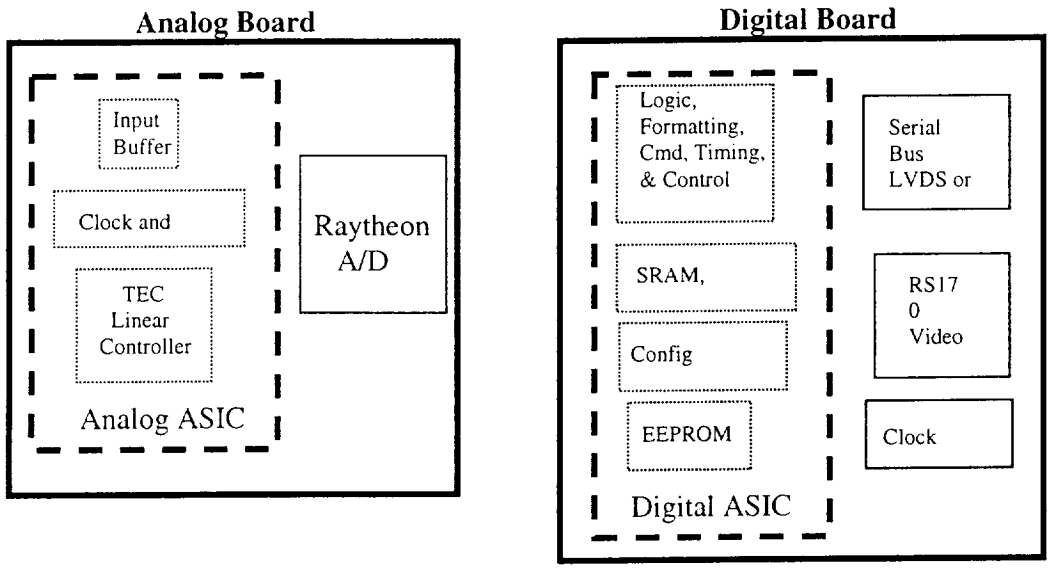
We have mad significant progress developing a more compact electronics package. As a basis we examined a miniature electronics board set developed for non-spaceflight applications. We are considering several electronics designs developed within Raytheon for Raytheon developed microbolometer arrays. We have evaluated space qualified replacement parts, FPGAs, and ASICs. A basic block diagram is shown below:

Miniature Camera Block Diagram



This design approach provides the basic camera functions in a two-board configuration without the large expense barrier of one or more ASICs. If a program budget allows, two ASICs, one analog and one digital, wloould further promote miniaturization. Below is a block diagram indicating the functions which could be designed into the ASICs.

ASIC Implementation Block Diagram



We have also begun to evaluate approaches to miniaturization of another THEMIS electronics function, data compression. Lossless compression of science data was done on the THEMIS program by using the USES chip, an ASIC developed by U. of New Mexico, and manufactured by the rad-hard foundry of UTMC. However, ASIC's are expensive to buy in small quantities, and there are large dollar costs and dollar and schedule risks if your program must fund a foundry 'run'.

We have found there are private intellectual property (IP) cores available that can be applied to FPGA's which are rad-hard. ACTEL and XILINX are the primary suppliers of rad-hard FPGA's. There are two third-party IP providers who are interested in adapting their lossless compression IP cores for our science data application. This involves changing their algorithm parameters from 8 bit data oriented operation to 10 bit, or 12, 14, or 16 bit pixel samples. Five sample data files have been sent to the two vendors: the first three are 8 bit data type, and #4 and #5 are with 10 bit data sample values. Because of the company proprietary requirements of the third party vendors, this report refers to them as IP vendor A and IP Vendor B. The development is ongoing, as the vendors more fully understand the application and design issues. Both vendors are confident that their 8 bit compression algorithms can be efficiently converted into 10, 12, 14, and 16 bit data type operation. We are studying preliminary results and comparing them with USES algorithm software results.

SUMMARY

The Advanced THEMIS Project, as proposed to be refocused, anticipates achieving its major goals. A 1Q schedule extension request is being prepared.. We are making progress setting up a test set to perform our key detector performance measurement tasks and defining a routes to creating miniature radiation tolerant electronics with THEMIS capabilities..

TABLE I.1 - TASK PLANS FOR ADVANCED THEMIS PROJECT					
WBS TASK	**DESCRIPTION OF SCOPE**	**PERIOD OF PERFORMANCE (MO 1 IS JANUARY 2001)**	**EST. MATERIAL AND ODC $**	**LABOR HRS.**	**PROGRESS THROUGH Q5**
1. Requirements Definition	Develop requirements for IR insitu and remote sensing of the surface and atmosphere of planetary objects	Mo 7-9		195	Essentially complete for Task 2
2. Detector Characterization and Design Modifications					
2A. Spectral Response Characterization and Design Modifications	Characterize the spectral-radiometric response of the 25μm microbolometer FPAs and make design changes to improve sensitivity in regions of the spectrum which promise strong scientific return. Use NICOLET FT-IR spectrometer.	Mo 1-24	32000	794	Identified and tested spectral source. Repair required. Tested new FP temperature controller. Testing of electronics complete. Packaging of 25μm detectors completed.
2B. Noise Characterization	Characterize the 1/f noise and output drift of the microbolometer FPAs	Mo 19-24		110	Determined type of data to acquire and analysis approach
2C. Radiation Testing	Measure the operating characteristics of two microbolometer FPAs in standard vacuum packages under increasing dose levels, until failure	Mo 22-24		150	
3. Instrument Performance Model	Develop end-to-end instrument performance model	Mo 21-24		168	
4. Radiometric Calibration Approach	Develop design approaches to on-board radiometric calibration for science missions studied in Task 1	Mo 22-24		128	
5. Spectral Imaging Demonstration	Multispectral imaging demonstration to confirm work on detector characterization, design and fabrication, calibration approaches, and the sensor performance model	Mo 22-24	5000	184	
6. Flight Inst. Definition and Final Report	define an Advanced THEMIS flight instrument for a future mission (e.g. Mars 2007 lander-rover)	Mo 19-24		118	Compact electronics design concept has been developed from a proven nonspace miniature camera design. Compact implementation of lossless data compression in FPGA's is being studied.
7. Educational/Public Outreach Activity: Teacher Seminar and	conduct a primary-secondary teacher workshop and a public lecture on planetary exploration	Mo 20-24	3450	60	

TABLE I.2 – REVISED LABOR BUDGET FOR ADVANCED THEMIS PROJECT 9/2002			
WBS TASK	**LABOR BUDGET (HRS.)**	**LABOR THROUGH 9/13/2002 (HRS.)**	**PROPOSED ADJUSTMENT TO SOW**
1. Requirements Definition and Program Management	333	195	Essentially complete for Task 2
2. Detector Characterization and Design Modifications			
2A. Spectral Response Characterization and Design Modifications and Noise Characterization	1475	995	Resources focused here to compensate for test hardware problems and detector packaging problems.
2B. Radiation Testing	0	0	Delete task in favor of 2A..
3. Instrument Performance Model and Flight Instrument Definition	491	91	
4. Radiometric Calibration Approach	0	0	Delete task in favor of 2A.
5. Spectral Imaging Demonstration	0	0	Delete task in favor of 2A.
6 Final Report	80	0	
7. Educational/Public Outreach Activity: Teacher Seminar and Public Lecture	0	0	Delete task in favor of 2A.
Total Project	2379	1379	

Public Lecture					
Total Project		24 mo	40K	1907	